How Much Nitrogen is There in the Spring from Fall-Applied MAP, DAP, and Ammonium Sulfate?

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PURPOSE

To determine the availability of N to corn from fall-applied diammonium Phosphate (**DAP**) and monoammonium phosphate (**MAP**) fertilizers compared to spring applications

Laboratory Experiment

- Soil type- Drummer sicl
- Fertilizer rate- 20 & 40 ppm N
- Soil fertilizer mixture incubation
  - 2 weeks at 80% field capacity
  - 14 weeks at 80% or 120% field capacity
- Sampled every two weeks for inorganic N

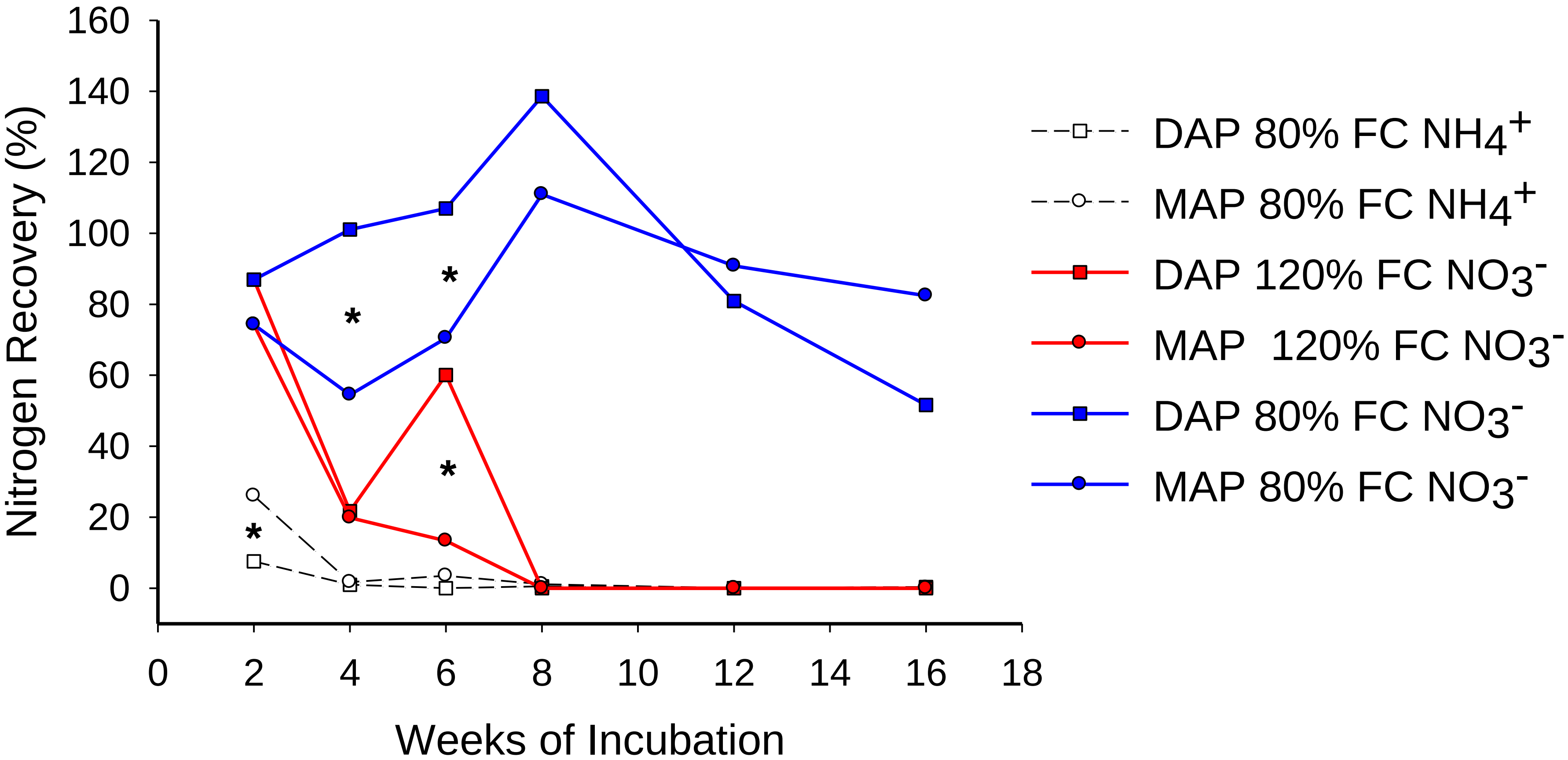
- Fall P and K applications done at warm soil temperatures (above 50° F)
  - Activity of nitrifying bacteria (conversion of NH_4^+ to NO_3^-) is high (Alexander, 1965)
- Nitrification and denitrification of DAP occurring faster than MAP
  - Mulvaney (1994) nitrification occurs
    - Urea >DAP>AMS>ammonium nitrate > MAP
    - Increase in soil pH with hydrolysis of urea and DAP favor nitrification relative to decline in pH with AMS and MAP (Allred and Ohlrogge, 1964; Lindsay et al., 1962)
  - Mulvaney and Khan (1995) denitrification occurs
    - NH_3 > urea > DAP > $(NH_4)_2SO_4$ > NH_4NO_3 > MAP
    - Alkaline conditions favor denitrification (Firestone, 1982).

Possible Consequences

- The use of rapidly-nitrifying fertilizer materials and application well before plant uptake increases the accumulation of NO_3^-
- Increasing risk of N loss from denitrification or leaching when soils are excessively wet in the spring prior to rapid N uptake by plants
- N loss results in an economical loss and important environmental concerns

Incubation of MAP & DAP

74% MAP 87% DAP nitrified after 2 weeks
Denitrification was fast with water-saturated soils

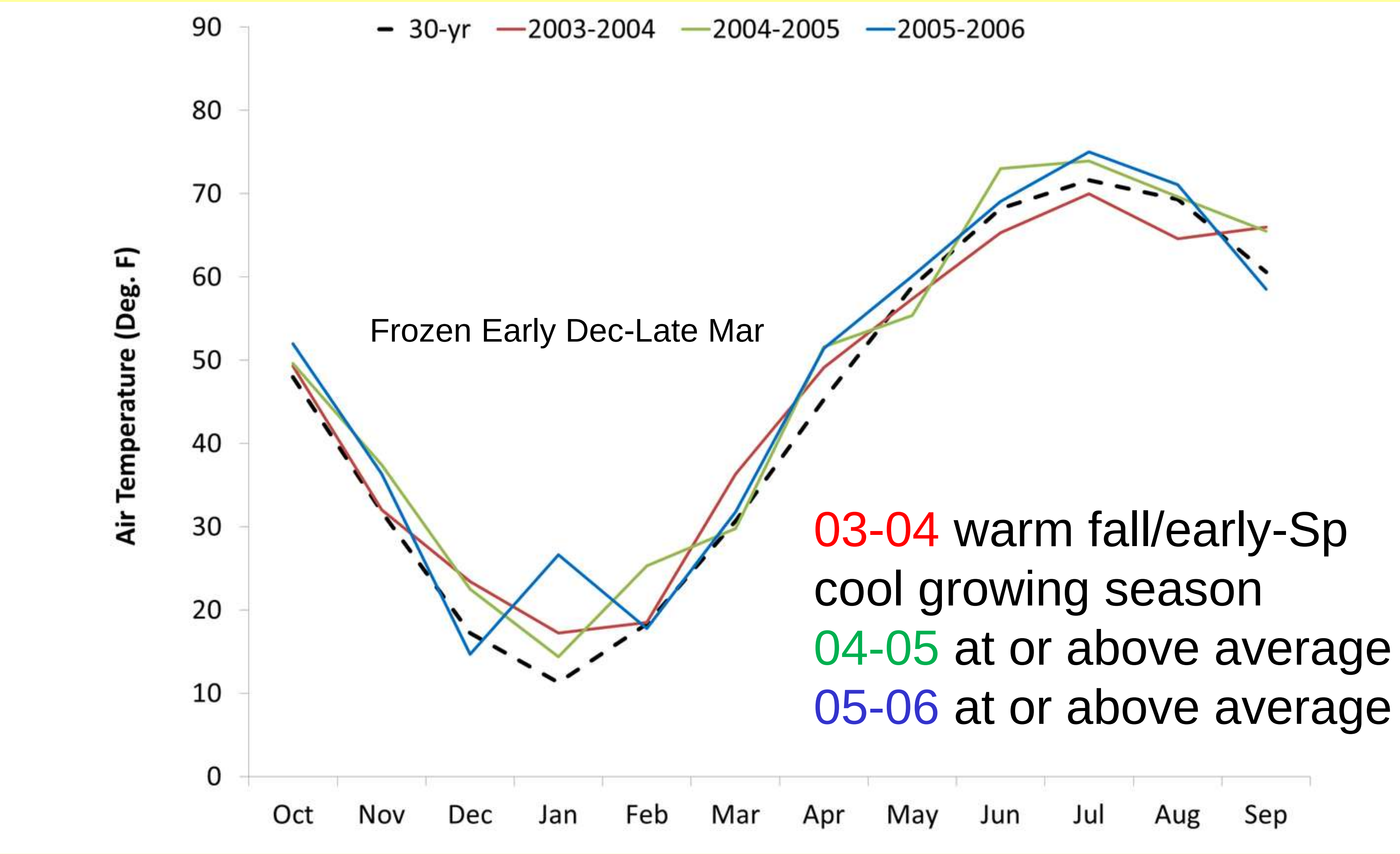


Procedures

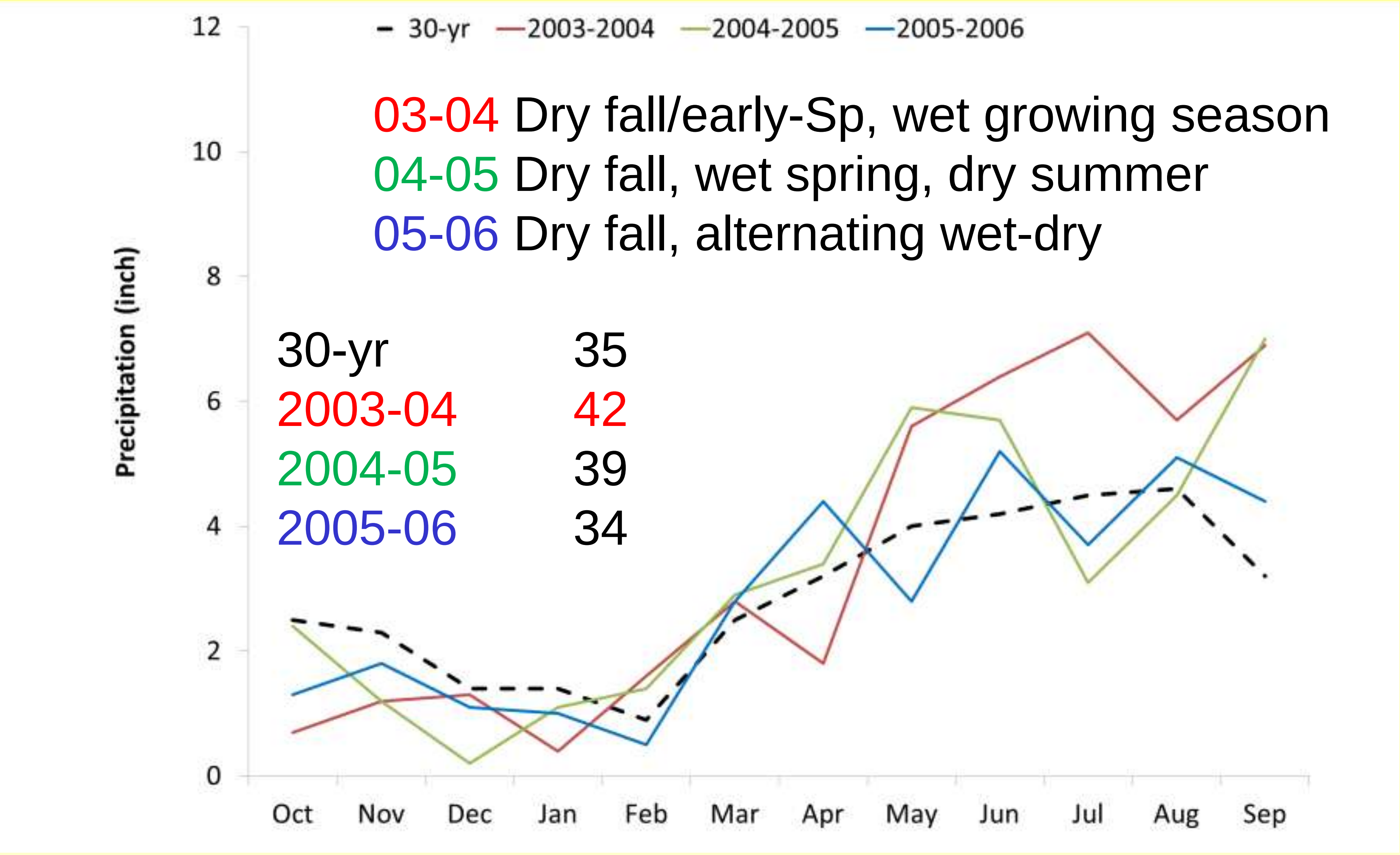
- Soil: Drummer sicl
- Previous crop: Soybean
- Conventional tillage
- RCBD
- N rates: 0, 40, and 80 lb N/A
- P rate: 100 lb P_2O_5/A on control
- Broadcast application
- Soil sampling: 2-weeks after application until freezing and then resumed on 2-week schedule in spring
- Yield at maturity
- **Apparent Recovery was estimated by subtracting nitrogen in the control plot from that of the treated plots and dividing by the applied nitrogen rate**

Location and cropping year	Nitrogen application date	Planting date	Hybrid	Final plant population	Harvest date	P	K	pH	OM
				Plants acre^{-1}		mg kg^{-1}	mg kg^{-1}		%
Waseca									
2004	10 Nov. 03 24 Apr. 04	28 Apr. 2004	NK N50-P5	33,100	19 Oct. 2004	54	215	7.6	6.5
2005	26 Oct. 04 4 May 05	4 May 2005	Mycogen 2E522	32,800	11 Oct. 2005	18	151	6.9	6.0
2006	1 Nov. 05 12 Apr. 06	23 Apr. 2006	Mycogen 2E522	32,600	6 Oct. 2006	23	180	6.8	6.9
Urbana									
2004	3 Nov. 03 5 Apr. 04	29 Apr. 2004	Pioneer 34B24	30,200	17 Sep. 2004	92	406	5.7	3.0
2005	10 Nov. 04 6 Apr. 05	2 May 2005	Pioneer 34B24	30,200	23 Sep. 2005	46	184	6.6	5.4
2006	2 Nov. 05 5 Apr. 06	8 May 2006	Pioneer 34B24	29,600	27 Sep. 2006	51	184	6.6	5.3

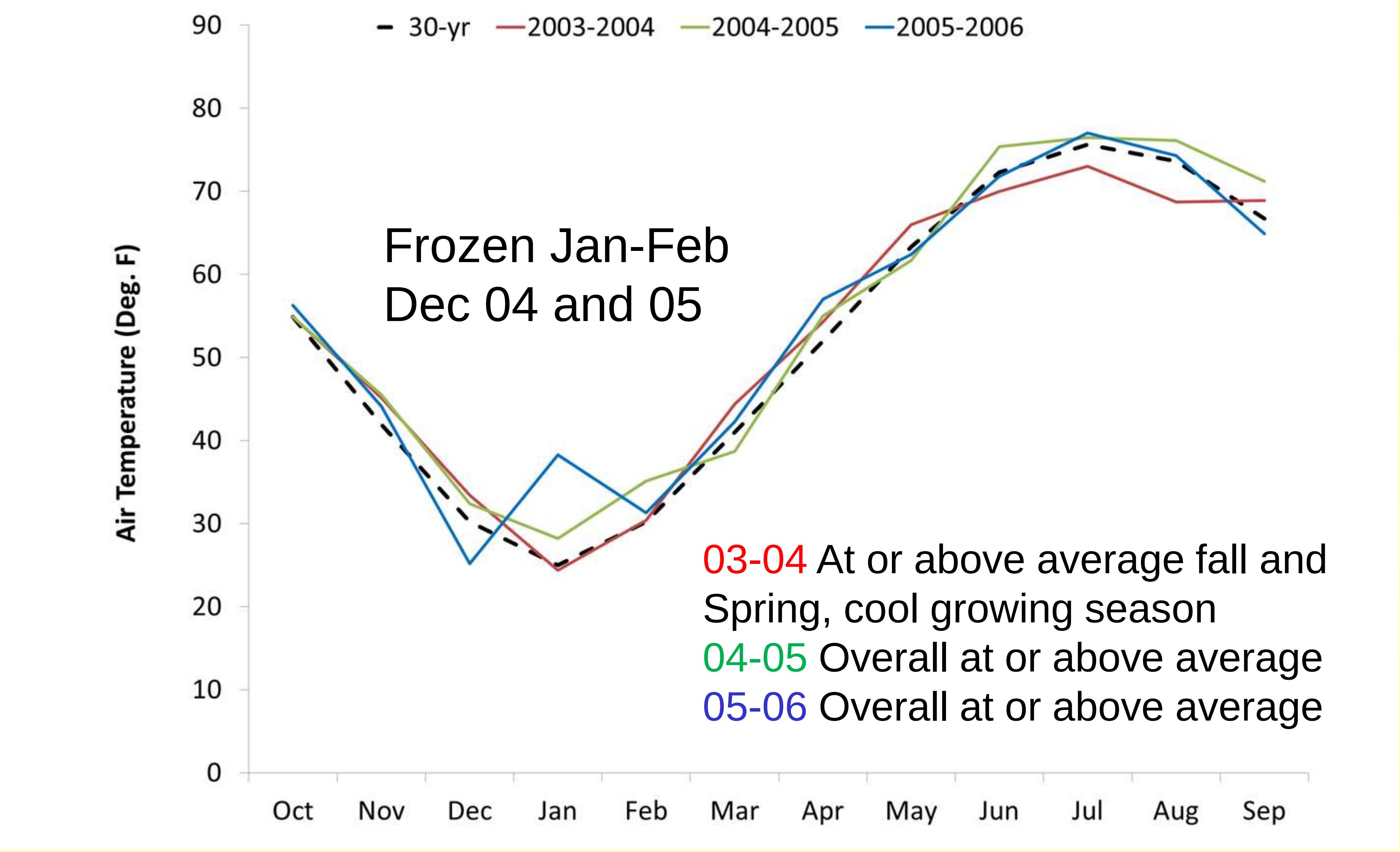
Air Temperature-Waseca



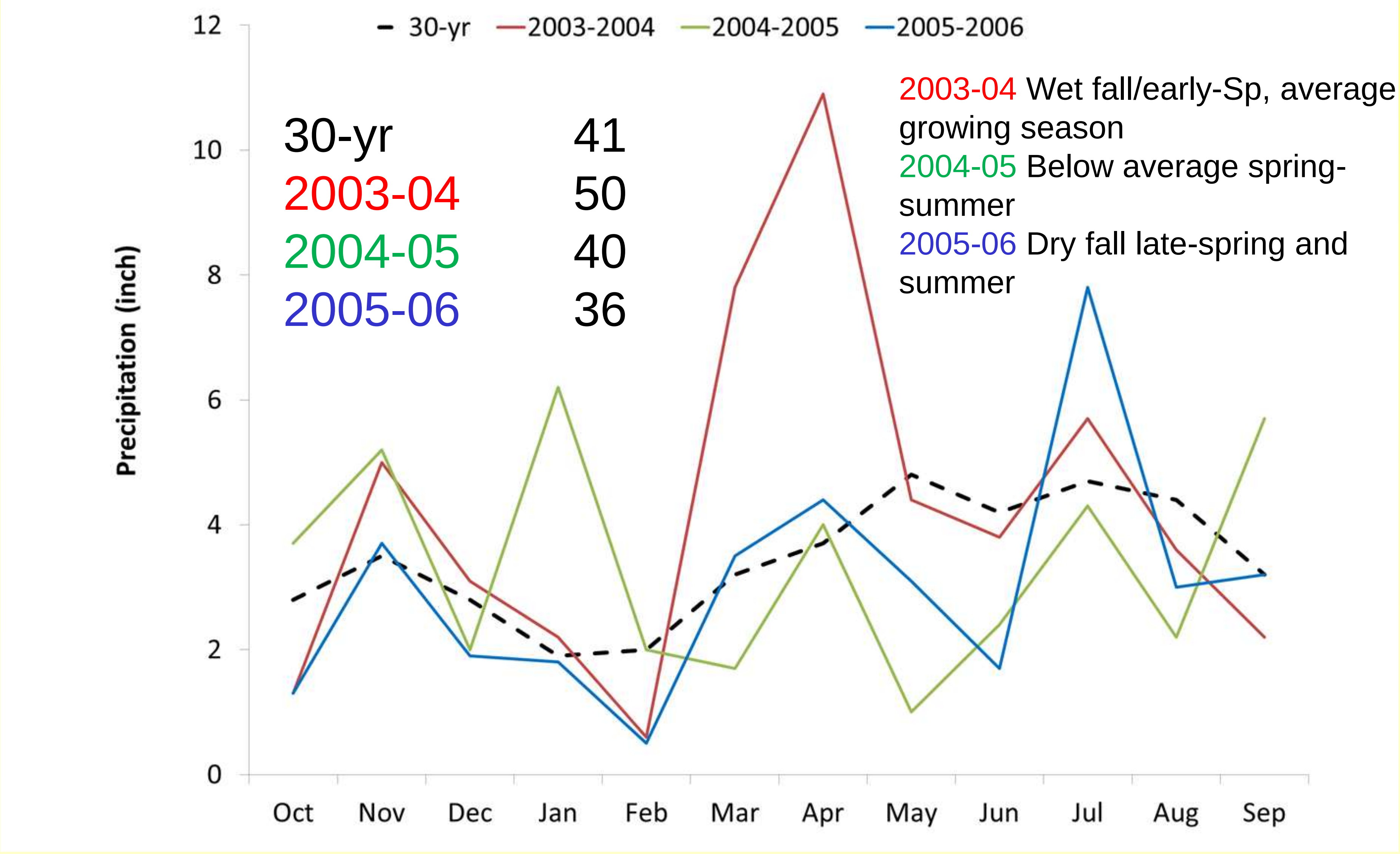
Precipitation-Waseca



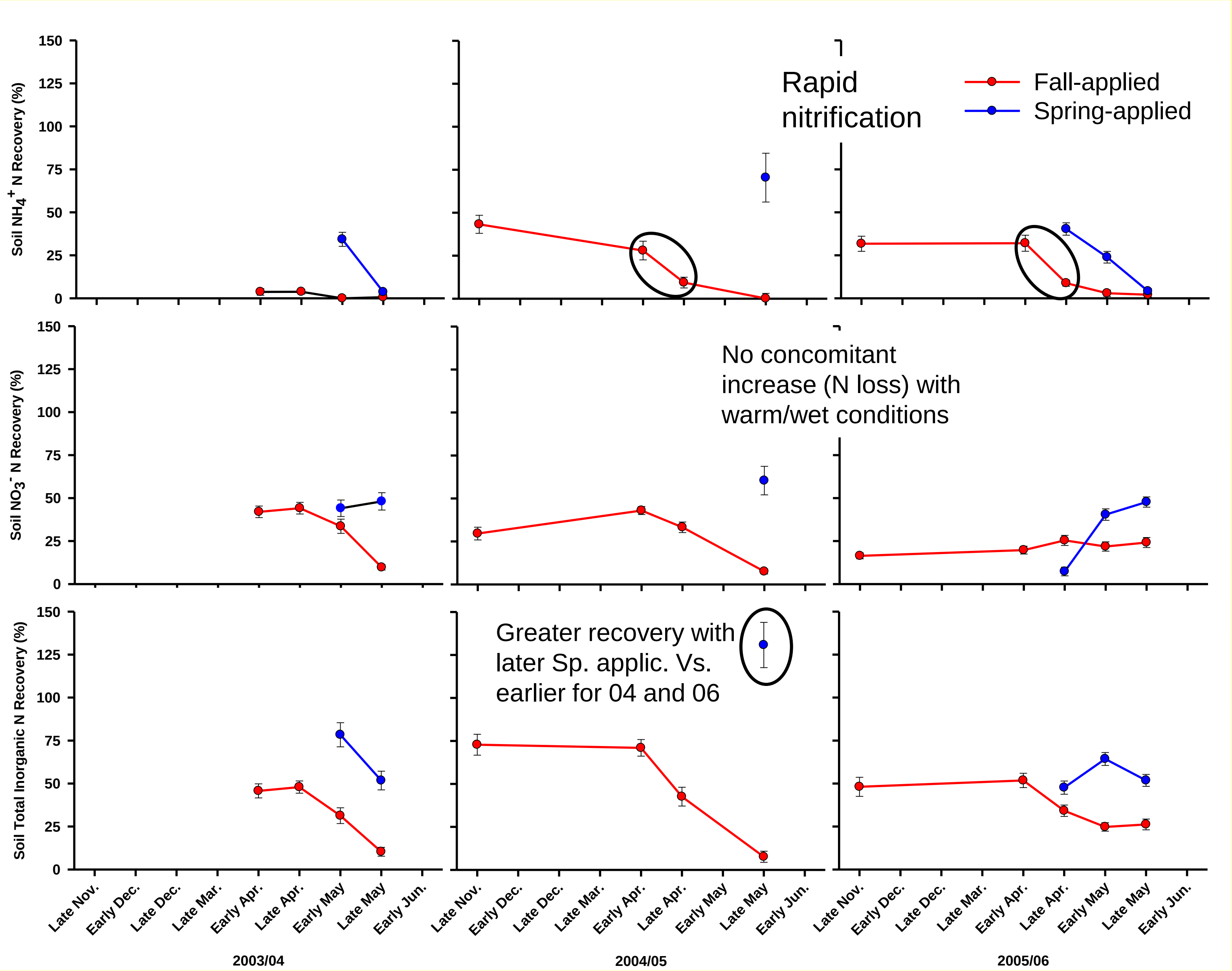
Air Temperature-Urbana



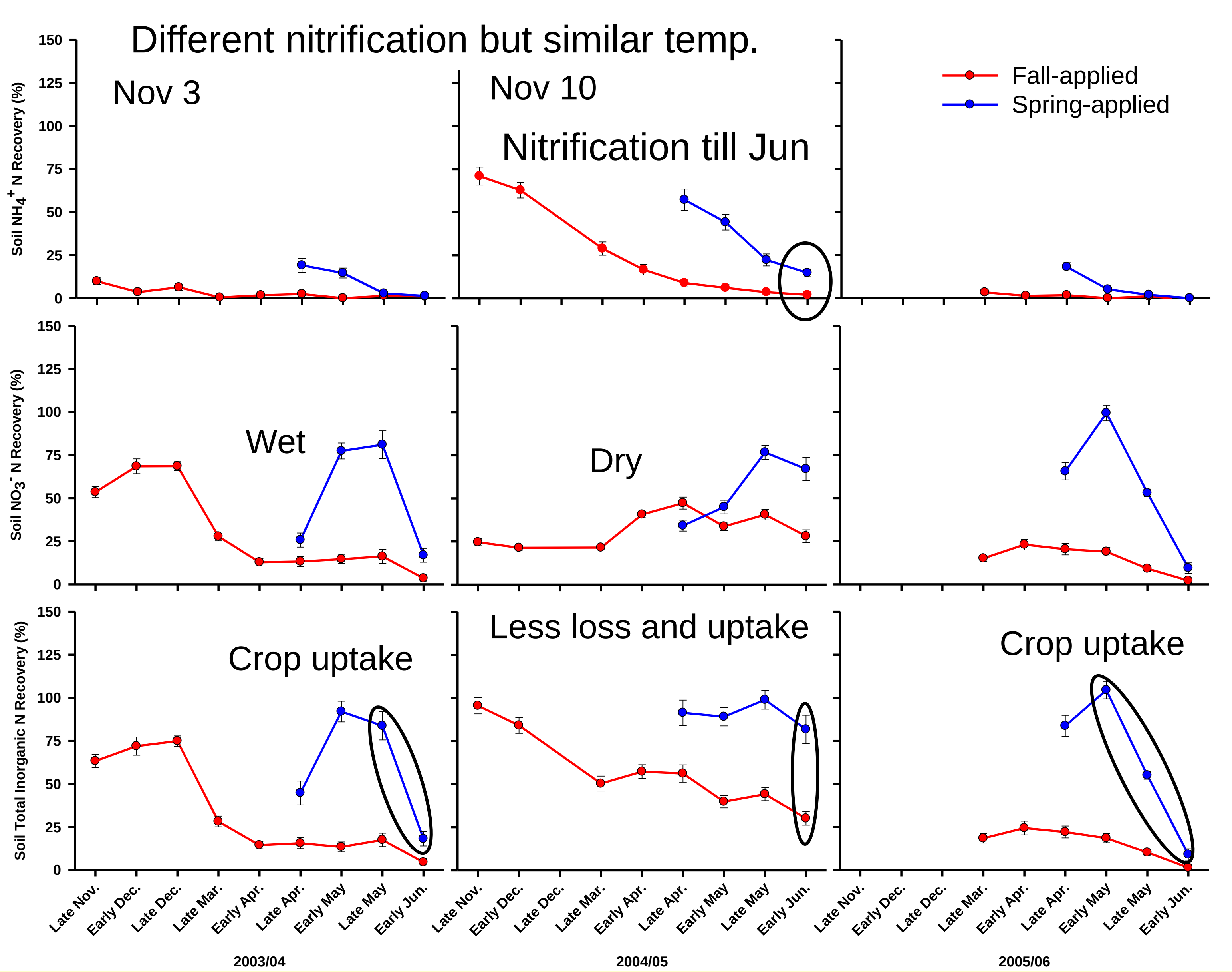
Precipitation-Urbana



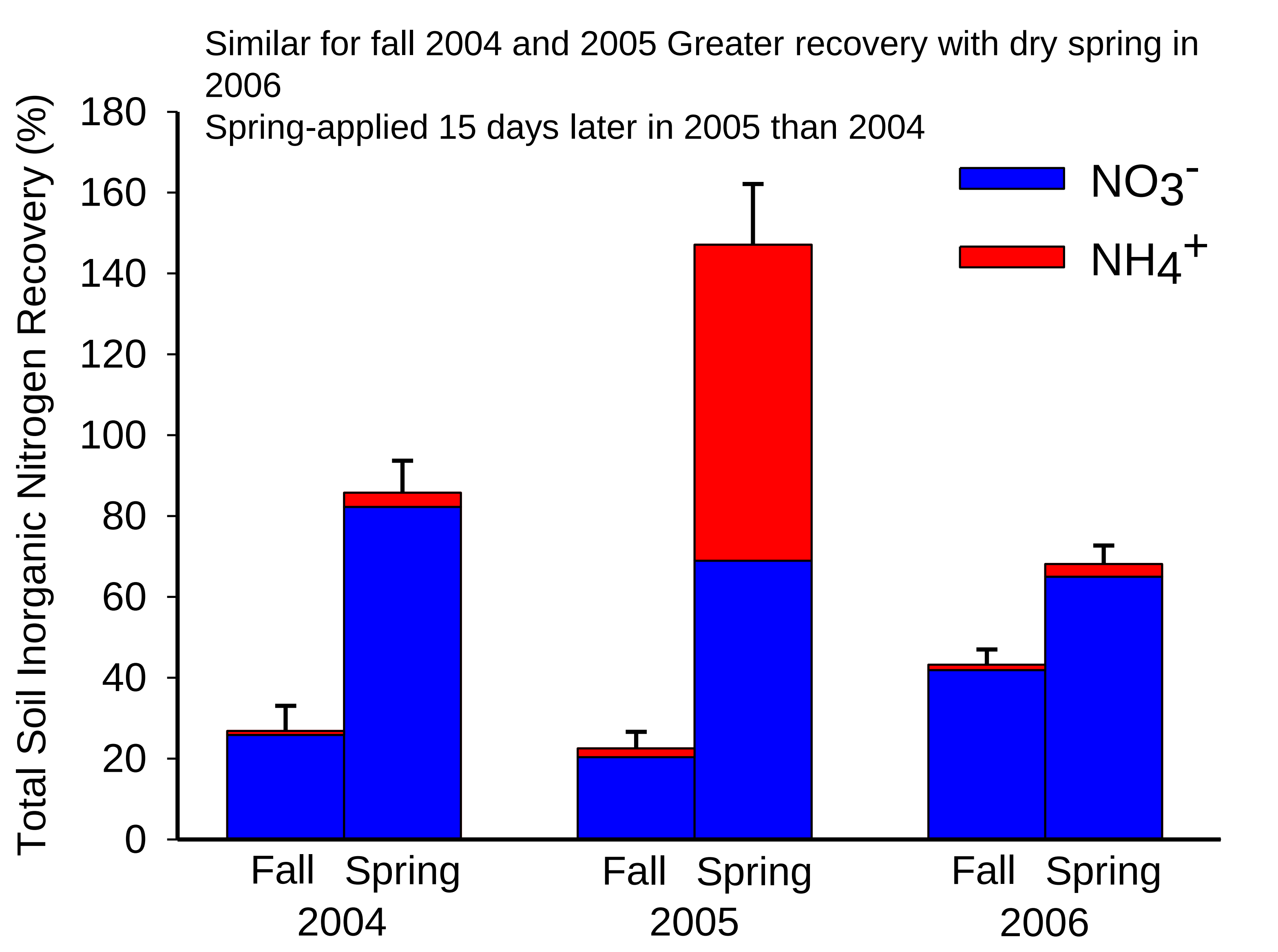
Apparent soil N recovery on top 6 inches Waseca (across rate and source)



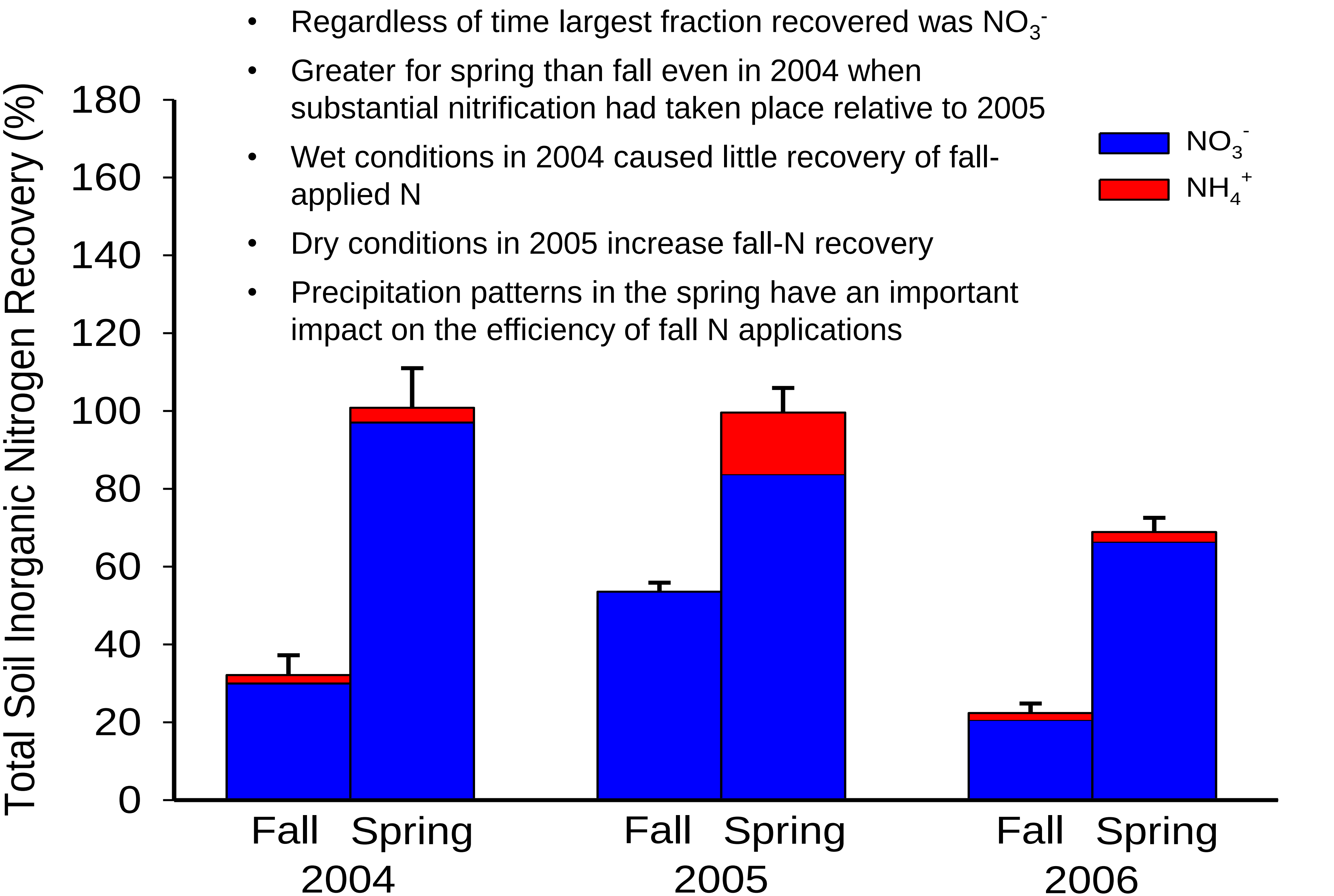
Apparent soil N recovery on top 6 inches Urbana (across rate and source)



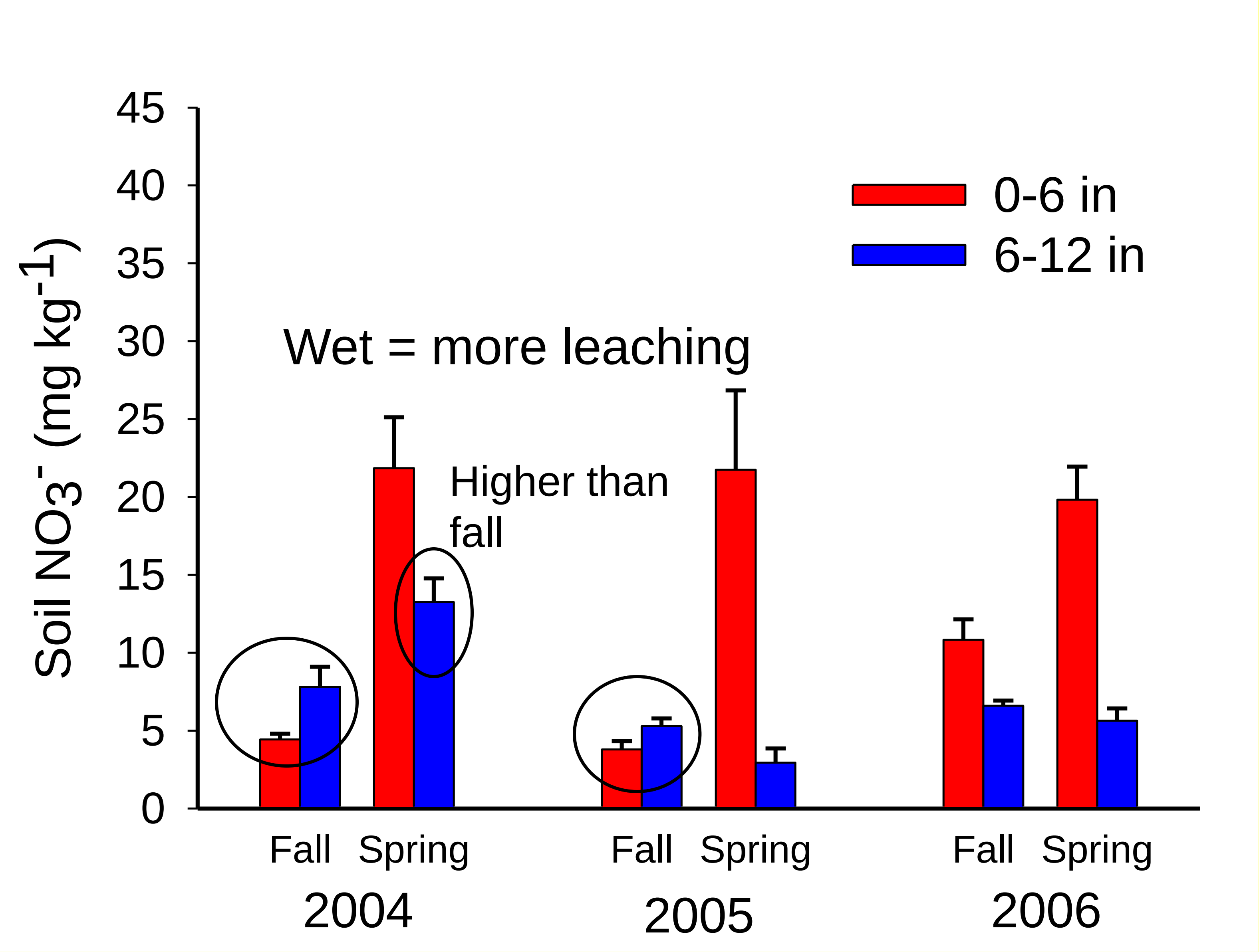
TIN recovery on top 12 inches of soil at the end of May, Waseca



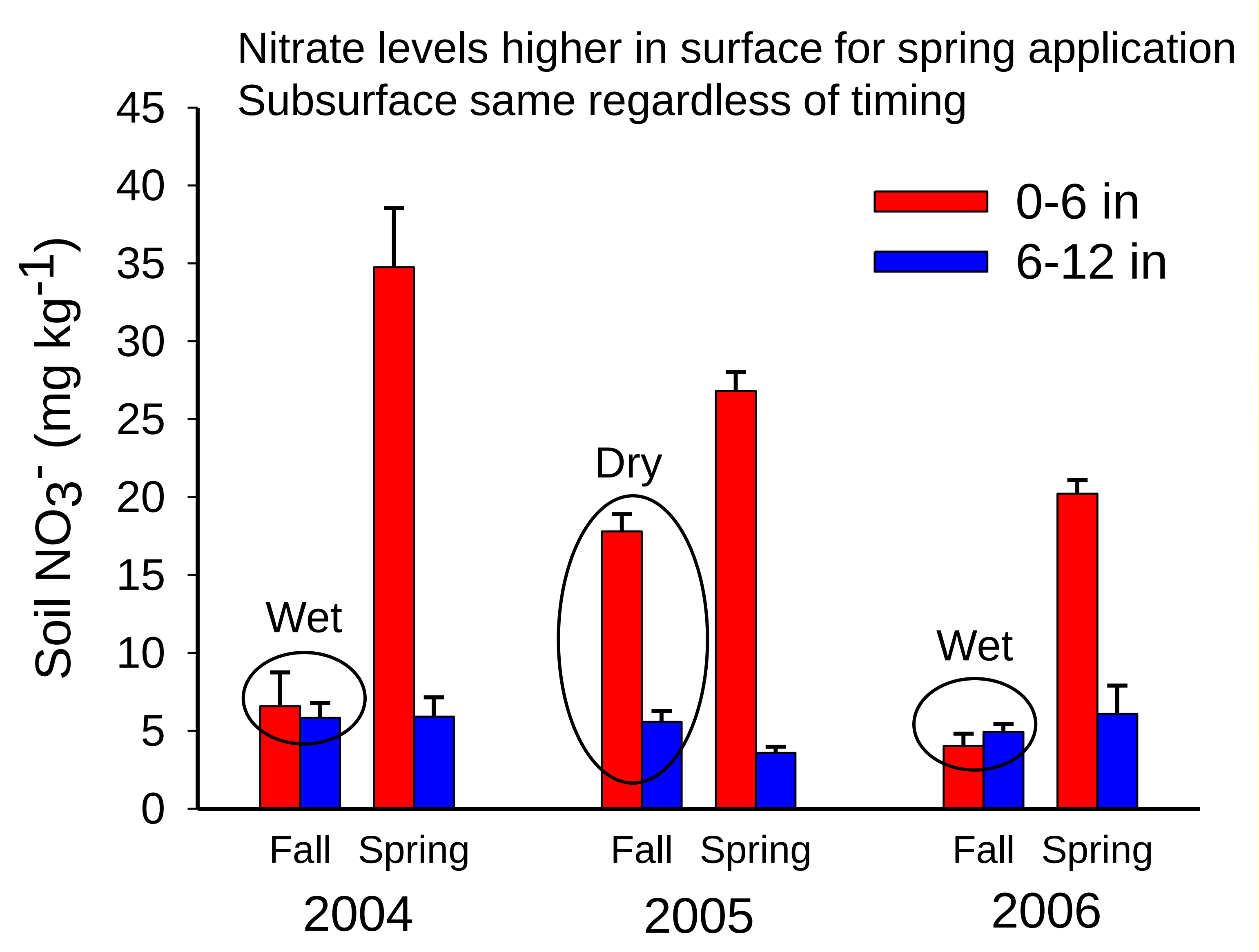
TIN recovery on top 12 inches of soil at the end of May, Urbana

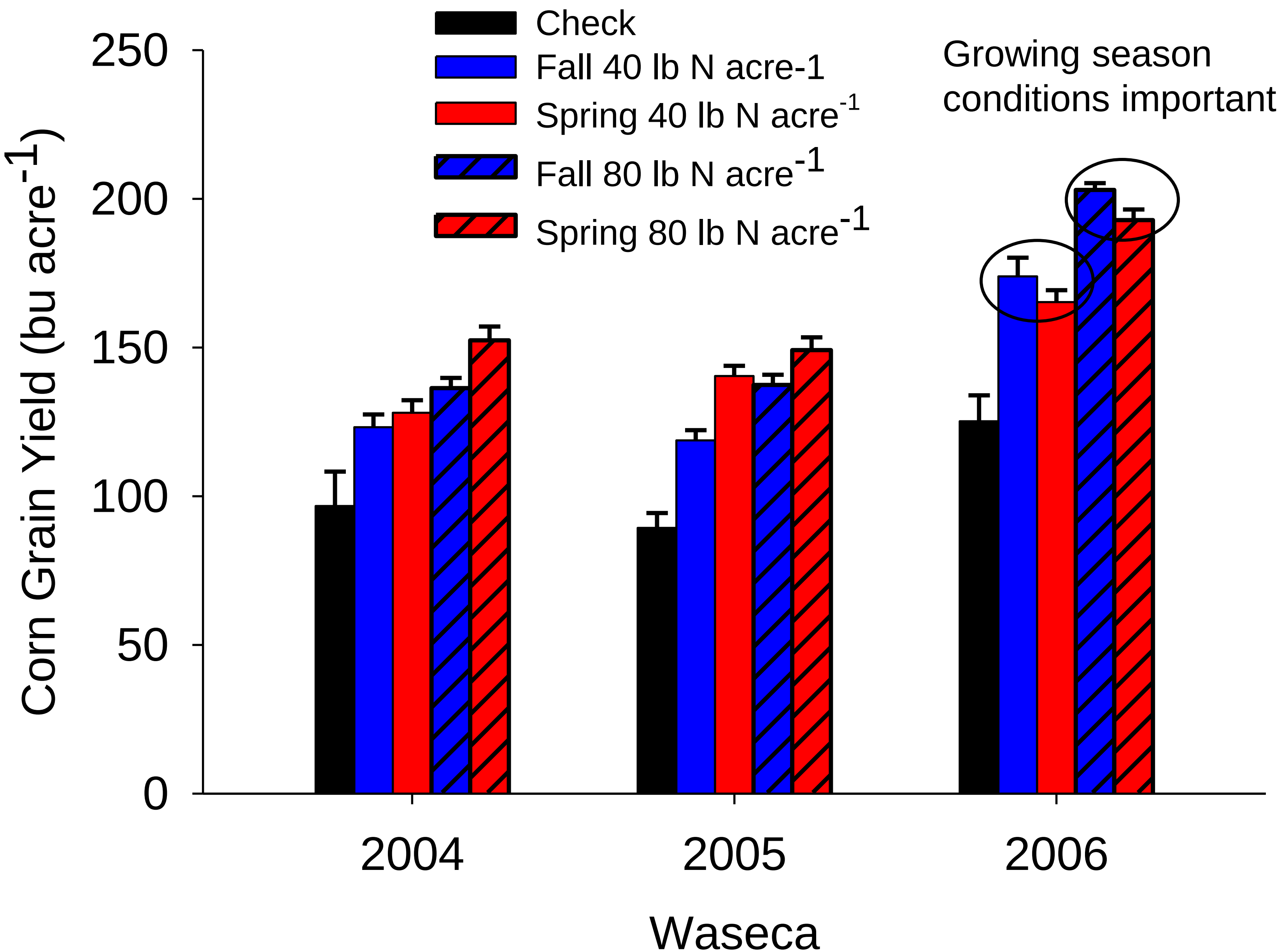


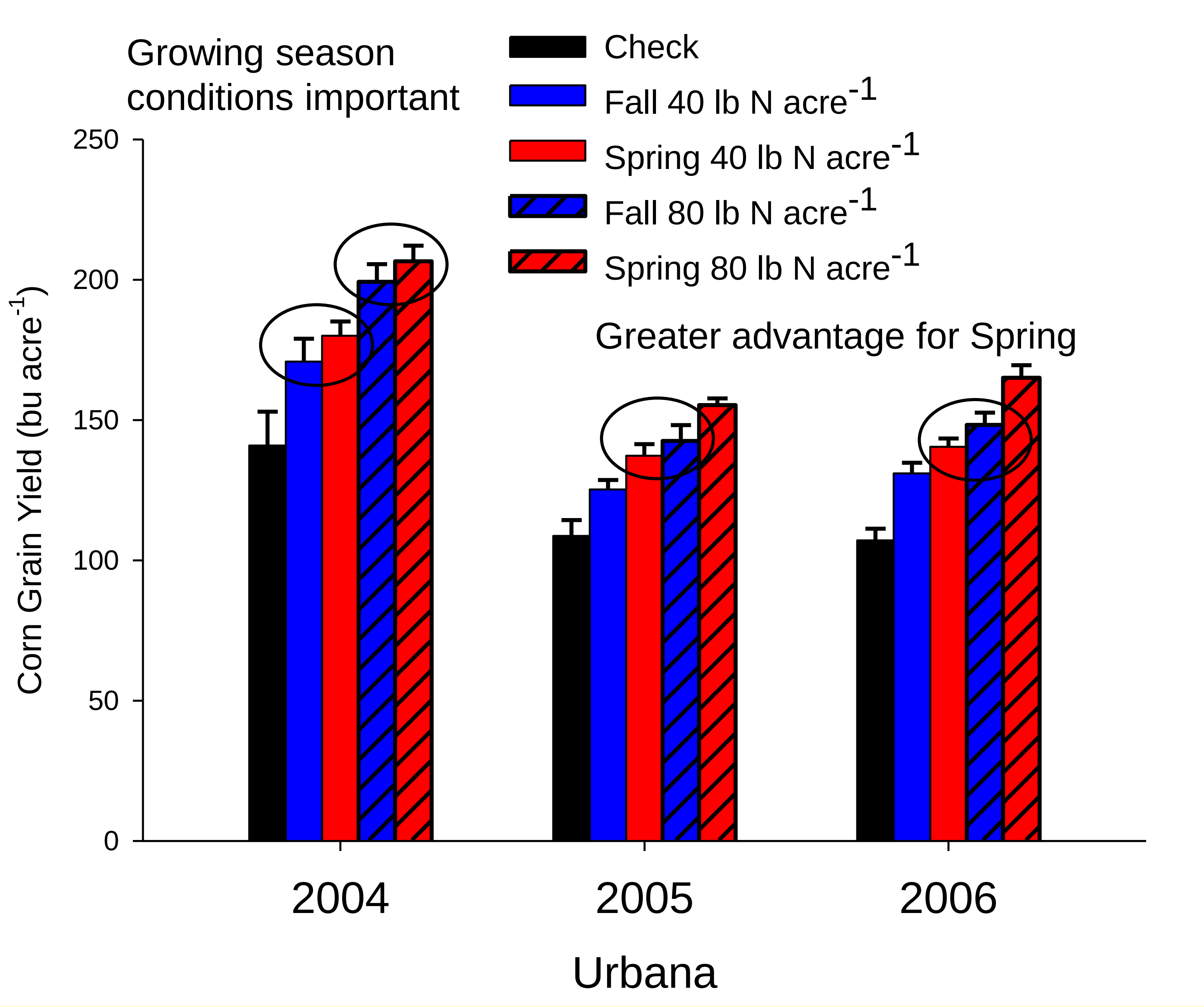
Soil nitrate above the check at the end of May for the 80 lb/acre rate across all sources, Waseca



Soil nitrate above the check at the end of May for the 80 lb/acre rate across all sources, Urbana




Check
Fall 40 lb N acre-1
Spring 40 lb N acre-1
Fall 80 lb N acre-1
Spring 80 lb N acre-1
Growing season conditions important
Corn Grain Yield (bu acre-1)
250
200
150
100
50
0
2004
2005
2006
Waseca



Growing season conditions important
Check
Fall 40 lb N acre-1
Spring 40 lb N acre-1
Fall 80 lb N acre-1
Spring 80 lb N acre-1
Greater advantage for Spring
Corn Grain Yield (bu acre-1)
0
50
100
150
200
250
2004
2005
2006
Urbana

CONCLUSIONS, Lab

- Nitrification occurs rapidly
- Under saturated water conditions denitrification is rapid

CONCLUSIONS, Field

- Similar results for MAP and DAP across sites, years, rates, and time of application
- When soil-saturating rainfall and warm temperatures occurred after substantial nitrification of NH_4^+, leaching and denitrification can result in nearly all of the N from fall-applied MAP or DAP to be unrecovered
- 35% (Urbana) and 31% (Waseca) of fall-N was recovered as inorganic N from the soil at the end of May

CONCLUSIONS, Field

- A typical 200 lb acre^{-1} rate of MAP and DAP amounts to only 22 and 36 lb N acre-$^{-1}$, respectively
- The low recovery of N from a fall application would reduce N supply at the less responsive portion of the N response curve
- At most, the reduction from EONR yield is close to 3%
- Regardless of rate or source, the fate of fall- and spring-applied N is mostly impacted by weather conditions in early spring
- Adequate crop-growing conditions during the growing season can compensate earlier soil N losses

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- Fernández et al. 2010. Agron. J. 102:1674-1681

THANKS